REMARKS

Summary

This Response is responsive to the final Office Action mailed on April 17, 2007. Claims 22 and 23 are amended. Claim 25 is new. Claims 22-25 are pending.

Claims 22-24 are rejected under 35 U.S.C. § 103(a) as being anticipated by Fadeley (US 6,234,100) in view of Ratzel (US 4,477,753) and Tyler (US 4,027,202).

Applicant respectfully traverses these rejections in view of the amended claims and the following comments.

Discussion of Amended Claims

Claims 22 and 23 are amended to clarify that the monitoring comprises continuous monitoring and comparison of the states of the first and second relays with the control signals from the manually operated control means.

Claim 25 is a new dependent claim corresponding to claim 24.

Discussion of Fadeley

Fadeley discloses a boat thruster control system consisting of a joystick (20) for operating a switch (92) connected to a port and starboard thruster contactor (94, 96). The thruster (16) is controlled by left/right movements of the joystick (Col. 8, lines 12-20).

The arrangement disclosed in Fadeley is common to most thruster control systems and can be seen as background art for the present invention. As acknowledged by the Examiner, Fadeley does not disclose that switch 92 is an operating relay having first and second relay windings for actuating first and second relay contacts as claimed by Applicant. Further, as also acknowledged by the Examiner, Fadeley does not disclose a safety control device for a thruster control system as claimed by Applicant.

Discussion of Ratzel et al.

The Examiner relies on Ratzel as disclosing a safety control device. However, contrary to

the Examiner's assertions, the safety device disclosed in Ratzel is far removed in both design and function from Applicant's claimed invention.

Ratzel discloses a safety interlock device for an electric positioning system. The positioning system comprises a motor (14) connected via an operating relay to a supply voltage source (17). The operating relay has first and second relay windings (15, 16) for actuating first and second relay contacts (18, 19) for making the motor run in a first or a second direction (Col. 2, lines 46-64). The safety interlock device comprises a logical circuit (34) arranged for receiving input signals representing the voltage level from each of the control signal input terminals (10, 11), signals representing the voltage level from each of the relay windings (15, 16) and signals representing the voltage level from each side of the motor (14). The safety interlock is further arranged for applying a control signal to both input terminals (10, 11) for blocking the operation of the motor (14) when it is detected that the motor (14) is running in the absence of an input signal on both input terminals (10,11) (Col. 3, lines 26-64).

With the interlock device disclosed in Ratzel, the motor is blocked by forcing both input terminals to a high level, thereby applying a positive voltage to both sides of the motor. If this interlock system is used for a thruster control system, it would be impossible to maneuver in either the port or starboard directions after the system has come into a blocking state because both input terminals are constantly forced to a high level by the logical circuit (34). The system of Ratzel does not allow for reduced functionality, such as allowing the motor to run in the direction according to the burnt in relay.

In contrast to Ratzel, with the thruster control system claimed by Applicant, it is still possible to maneuver the boat in the direction represented by the failed relay contact. With the present invention, in case of a failed relay contact, a control signal is applied by the safety unit to the other of the relay contacts (not to both input terminals as in Ratzel), so that the electric circuit is broken and the motor stops. If then, an input control signal appears as a result of a helmsman trying to maneuver the boat in the direction represented by the failed side, the safety unit according to the invention will no longer detect an erroneous condition because there is an input control signal and there is no longer a discrepancy between the input control signal and the

voltage over the failed relay contact. The result is that the safety unit will no longer provide a control signal to the opposite side and the thruster will operate in the desired direction.

As an example of the operation of the present invention, assume that there is a thruster system with a joystick, an operating relay and a thruster motor. The safety unit of the present invention is situated in the circuit between the joystick and the operating relay. When operating the joystick in, for example, the port direction, a port control signal is given to the safety unit. The safety unit will further issue a port signal to the Port winding of the operating relay and the port relay contacts will activate the current to the thruster motor. The thruster motor will then operate in the Port direction. If during this operation the port relay contact is burned, the helmsman will not discover this failure until he releases the joystick. The safety unit that continuously monitors the state of the relays and compares the state of the relays with the control signals will immediately, as the helmsman releases the joystick, detect or "discover" that there is a discrepancy between the lack of a control signal from the joystick and the state of the burned relay. This error will not be detected before the joystick is released, as until the joystick is released there is no discrepancy between the relay state and the control signal. The safety unit will then provide a signal to the opposite (starboard) relay winding and the starboard relay contacts will be closed to provide voltage to the opposite, starboard relay. This would normally make the motor run in the starboard direction if the port relay was not stuck. Since both sides of the motor now have the same voltage level, the motor will stop. However, since the safety unit monitors the signal from the joystick and the state of the relays it is possible for the helmsman to operate the boat in the port direction. This is possible since if a port signal appears from the Joystick due to the helmsman moving the joystick in the port direction, there is no longer any discrepancy between the port input control signal and the state of the port relay. The safety unit will then return to normal state and release the starboard relay as long as the joystick is held in the port direction. Thus, with the present invention it is possible to steer the boat in the direction that corresponds to the failed relay contact (note however that steering the boat in the direction corresponding to the other relay contact, in this example the starboard direction, will not be possible as moving the joystick to operate the starboard relay will result in both sides of the

motor having the same voltage level, which will stop the motor). The system of Ratzel does not provide the aforementioned advantage of being able to operate the motor in the direction of the failed relay.

Both from a practical and a safety aspect the above indicated difference is important because after detecting the failure, the helmsman is aware of the thruster now functioning in only one direction, either starboard or port and may plan to dock the boat to starboard or port accordingly. Thus it is still possible to maneuver the boat with the reduced functionality provided by Applicant's claimed invention if one of the relay contacts fails. A helmsman could also be better able to avoid dangerous situations such as running aground by a having available at least one thruster direction. This situation is significantly better than the resulting operation proposed by Ratzel, where a control signal is applied to both input terminals, thereby blocking all further operation.

The reason that the system of Ratzel is not able to provide such reduced functionality in the event of a failed relay is that the lines from the input terminals (10, 11) to the drive stage of the relays are unbroken and when the signal from the logical unit is fed back to the input terminals through diodes (32, 33) it is impossible to monitor the actual state of the joystick since the feedback signal overrides the joystick signal.

Discussion of Tyler

Tyler discloses an AC voltage protection circuit used to protect a device, such as an AC motor, from abnormal line voltage such as low AC voltage levels which can cause damage to the motor.

It is common knowledge for an electrical engineer that an AC motor connected to a utility system has been deployed for a specific working load. The dimensions of the windings in the motor and the motor itself depend on the power delivered at normal operating conditions, such as line voltage level. If the voltage level drops, the engine may stall and become damaged. An objective of Tyler is then to disconnect the AC motor when an abnormal voltage level is detected to avoid damage to the AC motor.

However, those skilled in the art will appreciate that a DC thruster motor will not be damaged by low DC voltage levels. It will continue to run slower and with less power at reduced voltage levels. Thus there is no need to protect the DC motor as such against low voltage levels. However, as disclosed in Applicant's specification, there is a need to protect the relays against low voltage levels because of problems related to chattering and burning of the relay contacts when opening and closing the relay contacts at low voltage situations. Tyler is not directed towards the protection of relays against chattering and burning in.

In contrast to Applicant's claimed invention, Tyler proposes means for delaying the voltage rise related to the corresponding rectified halves of the AC voltage in the event there is a power failure for a duration longer than the time for discharging the capacitor (256). This time-delay circuit is dependent on the nature of the supply current being alternating (AC), and thus does not relate to DC protection of relay contacts.

The system of Tyler is intended for protecting an AC motor or device against low line voltage and applying a delay before re-exitation of the AC motor. The problem and the corresponding solution of Tyler is significantly different from the problem and the corresponding solution addressed in the present invention where the relays in a low-voltage DC circuit are protected from chattering and burning.

Chattering and burning in of relay contacts for DC motors has been a problem in the boat thruster industry for decades, and a solution for a safety device solving the problem of failure prevention, detection and handling has been demanded. However, according to the inventors, no such solution exists in the boat thruster industry. Instead of solving the problem, some manufacturers have started producing more complex and more expensive thruster control systems based on semiconductor technology such as MOSFETs and Thyristors. Considering the current needed for a DC thruster at 5-15 HP with 12 or 24 V operation, the costs of the thruster control circuit becomes much higher than with conventional relay systems due to the strong current required due to the high power demand and the low on-board battery voltage available.

Accordingly, the present invention satisfies a long felt need in the boating industry, which has not been met by the prior art such as Fadeley, Tyler, Ratzel and others.

The present invention is not disclosed or remotely suggested by the combined disclosures of Fadeley, Ratzel, and Tyler. In particular, none of these references, alone or in combination, disclose all the features of Applicant's claimed invention, including:

<u>continuously monitoring a state of said first and second relay contacts;</u>

<u>delaying a re-excitation of said first or second relay windings after a break if said monitored supply voltage is too low to maintain said relay in a stable pick-up state in order to avoid chattering and burning of said relay contacts;</u>

<u>continuously comparing said control signals with signals representing the state of said first and second relay contacts to determine whether one of said first or second relay contacts is erroneously activated to run the motor either in said first or second direction;</u> and

<u>if one of said first or second relay contacts is erroneously activated, actuating the other of said erroneously activated first or second relay contacts to supply the same voltage level to both terminals of the motor, thereby interrupting the current to the motor.</u>

As discussed above, Applicant's claimed invention provides the advantage of enabling the thruster to be operated in the direction of the failed relay, since in such a case the comparison of the control signal and state of the relay will not result in an error and the other of the relay contacts will not be actuated. Such an advantage is not disclosed or suggested in the prior art of record.

Further, it would not have been obvious to one of ordinary skill in the art at the time of the invention to incorporate the solutions proposed by Ratzel and Tyler into the system of Fadeley, and doing so would not have resulted in the claimed invention. The reason for this, as stated above, is the differences in the functionality and the non-applicability of the cited references with regard to the claimed invention. Only with hindsight impermissibly gained from Applicant's disclosure would one of ordinary skill in the art have arrived at the conclusions reached by the Examiner. For example, Tyler relates to a device to protect an AC motor from damage due to an abnormal voltage level, while the present invention provides protection for

relays of a DC motor from damage caused by low DC voltage levels. Fadeley discloses a simple boat thruster control system without an operating relay having first and second relay windings for actuating first and second relay contacts as claimed by Applicant and without any safety devices. Ratzel discloses a limited safety device for a reversible motor which completely shuts off the motor in the event of a failure of a relay and does not provide limited functionality in the event of such a failure. Accordingly, there is simply no suggestion or motivation to combine the teachings of Tyler, Ratzel and Fadeley.

Further, as indicated above, even in the unlikely event that one skilled in the art were somehow motivated to combine the teachings of Fadeley, Ratzel, and Tyler, one skilled in the art would not arrive at Applicant's claimed invention. If one skilled in the art were to combine the teachings of Fadely, Ratzel, and Tyler, one skilled in the art would arrive at a thruster control system having the limited safety device of Ratzel which completely stops operation of the motor in the event of a failed relay, as well as the safety device of Tyler adapted to protect the DC motor from low voltage. Such a device would not provide the limited functionality of permitting operation in the direction of the failed relay, and would not protect the relays from chattering or burning, as are provided by Applicant's claimed invention.

Applicants respectfully submit that the present invention is not anticipated by and would not have been obvious to one skilled in the art in view of Fadeley, taken in combination with Ratzel and Tyler or any of the other prior art of record.

Further remarks regarding the asserted relationship between Applicant's claims and the prior art are not deemed necessary, in view of the amended claims and the foregoing discussion. Applicant's silence as to any of the Examiner's comments is not indicative of an acquiescence to the stated grounds of rejection.

Withdrawal of the rejections under 35 U.S.C. § 103(a) is therefore respectfully requested.

Conclusion

The Examiner is respectfully requested to reconsider this application, allow each of the pending claims and to pass this application on to an early issue. If there are any remaining issues that need to be addressed in order to place this application into condition for allowance, the Examiner is requested to telephone Applicants' undersigned attorney.

Respectfully submitted,

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